

Why did three capelin stock collapses in the Barents Sea affect the ecosystem differently?

Harald Gjøsæter, Bjarte Bogstad and Sigurd Tjelmeland

Institute of Marine Research (IMR), Bergen, Norway

Extended abstract

(Full article included in special issue of Marine Biology Research (vol. 4, 2008), celebrating the 50 years of Norwegian-Russian research cooperation)

The Barents Sea capelin stock underwent drastic changes in stock size during the last three decades. There is circumstantial evidence that the capelin stock has been at very low levels during periods also earlier, and substantial fluctuations of capelin stock size may be an inherent trait of this ecosystem. The three stock collapses, which are well described, occurred in 1985-1989, 1993-1997, and from 2003-2006. The collapses had effects both downwards and upwards in the food web. The release in predation pressure from the capelin stock led to increased amount of zooplankton during the collapse periods. When capelin biomass was drastically reduced, its predators were affected in various ways. The cod experienced increased natural mortality because of increased cannibalism, the growth was reduced and the maturation delayed. Seabirds experienced increased death rates and total recruitment failures, and breeding colonies were abandoned for several years. Harp seals experienced food shortage, increased mortality because they invaded the coastal areas and were caught in fishing gears, and recruitment failures.

The three capelin collapses affected the predators differently. The effects were most serious during the 1985-1989 collapse and some effects can hardly be traced during the two last collapses. Various explanations why the first stock collapse affected the ecosystem more seriously than the last two are possible, but we explored the following two hypotheses:

1. A better supply of capelin for the predators during the two last collapse periods
2. A better supply of other food for the predators during the two last collapse periods

It was found that the stock size of capelin was, at average, somewhat higher during the second and third collapse compared to the first. Further, the biomass production from the capelin stock (calculated as the natural mortality coefficient multiplied by the average body weight) was about two times higher during the two last collapse periods. This quantity is an estimate for the amount of capelin available for its predators. These facts support the first hypothesis. We also found that the amount of capelin consumed by cod was smaller during the first collapse compared to the others. However, the cod stock was increasing during this period, and the capelin consumed per individual cod was only slightly larger during the two last collapse periods. Therefore, the first hypothesis can only partly explain why cod and other predators were less affected by the lack of capelin during the two last periods.

The second hypothesis is not so easy to test, because knowledge about the amount of alternative food is partly lacking. Analysis of cod stomachs shows that the total food intake was in fact higher during the second and third collapse period compared to the first one. But again, the food intake per capita was not. Food intake by weight may be partly misleading when comparing different prey species, since the energetic content may vary both with prey

species and time of the year. While alternative food mostly consisted of various crustaceans during the first collapse, fish prey like blue whiting, polar cod and haddock made up a substantial part of the alternative prey during recent years. No time series of consumption estimates of sea mammals or seabirds exists for this area, and consequently it is impossible to explore in detail how their food intake was affected by the lack of capelin in periods. It is known that harp seals are opportunistic feeders that partly shifted to other fish when the capelin disappeared. As a whole, it seems reasonable to conclude that the reason why the capelin predators did better was probably a better availability of alternative food during the two last capelin collapse periods.